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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : E21B 21/08, 47/06, 47/00, 49/00, 47/10, 44/00, 47/08		(11) International Publication Number: WO 99/00575
A3		(43) International Publication Date: 7 January 1999 (07.01.99)
(21) International Application Number: PCT/US98/13119		(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).
(22) International Filing Date: 26 June 1998 (26.06.98)		
(30) Priority Data: 60/051,614 27 June 1997 (27.06.97) US		
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Published

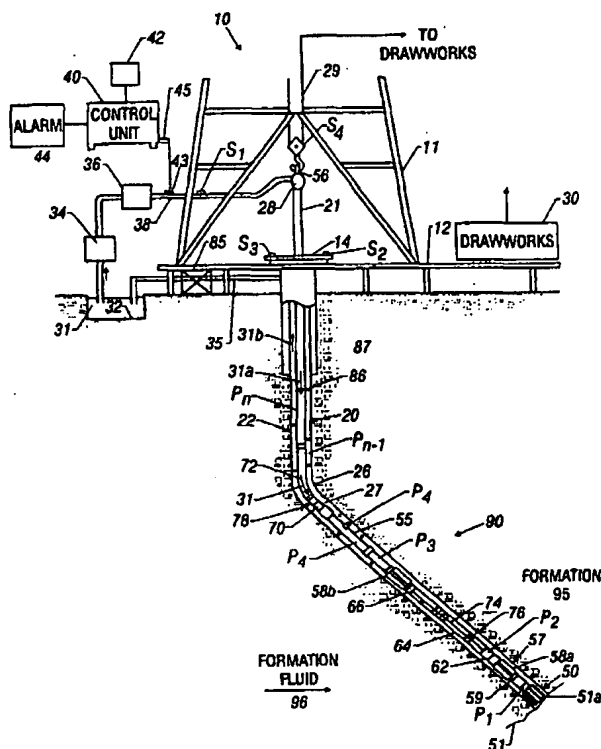
With international search report.

(88) Date of publication of the international search report:
15 April 1999 (15.04.99)

(54) Title: DRILLING SYSTEM WITH SENSORS FOR DETERMINING PROPERTIES OF DRILLING FLUID DOWNHOLE

(57) Abstract

The present invention provides a drilling system for drilling oilfield boreholes or wellbores utilizing a drill string having a drilling assembly conveyed downhole by a tubing (usually a drill pipe or coiled tubing). The drilling assembly includes a bottom hole assembly (BHA) and a drill bit. The bottom hole assembly preferably contains commonly used measurement-while-drilling sensors. The drill string also contains a variety of sensors for determining downhole various properties of the drilling fluid. Sensors are provided to determine density, viscosity, flow rate, clarity, compressibility, pressure and temperature of the drilling fluid at one or more downhole locations. Chemical detection sensors for detecting the presence of gas (methane) and H₂S are disposed in the drilling assembly. Sensors for determining fluid density, viscosity, pH, solid content, fluid clarity, fluid compressibility, and a spectroscopy sensor are also disposed in the BHA. Data from such sensors may be processed downhole and/or at the surface. Corrective actions are taken based upon the downhole measurements at the surface which may require altering the drilling fluid composition, altering the drilling fluid pump rate or shutting down the operation to clean wellbore. The drilling system contains one or more models, which may be stored in memory downhole or at the surface. These models are utilized by the downhole processor and the surface computer to determine desired fluid parameters for continued drilling. The drilling system is dynamic, in that the downhole fluid sensor data is utilized to update models and algorithms during drilling of the wellbore and the updated models are then utilized for continued drilling operations.



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INTERNATIONAL SEARCH REPORT

Interr. nat Application No
PCT/US 98/13119

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 E21B21/08 E21B47/06 E21B47/00 E21B49/00 E21B47/10
E21B44/00 E21B47/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 805 449 A (DAS) 21 February 1989 see column 1, line 28 - line 36 see column 5, line 27 - line 47 see column 6, line 50 - line 55	1-3
Y	---	4
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Y	---	4
X	US 4 297 880 A (BERGER) 3 November 1981 see abstract see column 2, line 11 - line 18	1-3,8
A	---	7
X	US 4 941 951 A (SHEPPARD) 17 July 1990 see abstract; claim 6	1-3
A	---	7
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

4 February 1999

Date of mailing of the international search report

11 02. 1999

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/13119

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 885 429 A (MEGYERI) 27 May 1975 see claims 1,3 see column 2, line 37 - line 43 ---	1-3,8,20
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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 307 684 A (SCHLUMBERGER LIMITED) 4 June 1997 see abstract -----	9,10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 98/13119

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional search

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
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Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-6

Drilling system comprising a plurality of pressure sensors, further a drilling system comprising a plurality of temperature sensors.

2. Claims: 7,8,18,19

Drilling system comprising one or plural sensors providing flow rate measurement, further a drilling system including a fiber optic sensor.

3. Claims: 9-13

Method of determining the relative amount of a component material of a drilling fluid, comprising tagging said component.

4. Claims: 14-17

System for monitoring a parameter of interest of a drilling fluid, comprising a spectrometric device.

5. Claims: 20,21

Downhole drilling tool comprising a fluid viscosity measuring device.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/13119

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